

Residual Effects of Organic Fertilizers on Chemical Properties of Soil and lead Concentration

B.tabibian, M.hoodaji and N.yazdani

Islamic Azad University, Khorasgan Branch, College of Agriculture, Department of Soil Science

ABSTRACT

Organic fertilizers contain high amount of micro nutrient and macro nutrient elements when these fertilizers were added to the soil cause increasing in growth gain and function in the plant. High concentration heavy metals lead to soil pollution and its transition to the food chain and risk human and animal health. The experiment was carried out in a completely randomized block design with seven treatments including : no fertilizer as a control (C), sewage sludge (SW), cow manure (CM), municipal solid waste compost (MC), sewage sludge and cow manure (50% SW + 50% CM), sewage sludge and municipal solid waste compost (50% SW + 50% MC) and cow manure and municipal solid waste compost (50% CM + 50% MC) at three levels of 0, 2.5 and 5 kg/shrub and three replicates in calcareous sandy loam soil at the botanical garden of Mobarekeh steel company. After 2 years, soil samples were collected from 30 cm depth and around the tree. Soil chemical properties also total concentration and DTPA– extractable of Pb were determined. The results showed that all treatments significantly ($P < 0/01$) increased organic matter (%OM), electrical conductivity (EC), and percent calcium carbonate (%CaCO₃), but there were no significant difference in pH and cation exchange capacity (CEC) in all treatments. Total concentration and DTPA– extractable of Pb were significant in different phase of lead extraction. Maximum and minimum parts were related to residual and exchange able Pb, which exchangeable part was significant in %1 level ($P < 0/01$). The use of cow manure cause to significant increase in total concentration and DTPA – extractable of Pb. The highest salinity belongs to control group. Salinity of Organic fertilizers didn't have significant difference. The highest pH value and percent organic matters belong to manure treatment .

Key words: Sewage sludge, Cow manure, Urban compost, Heavy metal, Soil properties

1.INTRODUCTION

Land application of organic Fertilizers like sewage sludge, municipal solid waste compost and animal manure is an excellent way of recycling both the nutrients and the organic matter contained in them. Apart from the agricultural use, this practice is becoming one of the most promising ways for the reclamation of soils with low organic matter content. However, the potential health risks associated with the presence of pathogens, heavy metals and organic pollutants are well known, as well as the short and long term effects that these contaminants have on soil, from the agronomic point of view (Sastre et al., 1996; Albiach et al., 2000; and Vasseur et al., 2000). Influence of organic substances on the availability of the heavy metals depends on the nature of these metals, soil types, and the organic matter properties, particularly the degree of humification (Walker et al., 2004). Organic matter has a vital role in controlling the mobility of heavy metals in soils. It may decrease the available concentrations of heavy metals in soils by precipitation, adsorption, or complexation processes (Bernal et al.,

2007) remediating effects of different organic wastes on heavy metal-polluted soils over the past years. For example, the addition of mushroom compost to a clay loam soil in Ankara, Turkey decreased the concentration of available Pb from 2.20 to 1.90 mg kg⁻¹ and Cd from 0.057 to 0.005 mg kg⁻¹ (Karaca,2004). Incorporation of cow manure to a paddy soil in China reduced the concentrations of available Pb and Cd by 76.1% and 25.7%, respectively (Li et al., 2008). In a calcareous soil in Murcia, Spain, the amount of available Pb was slightly reduced from 11.3 to 10.4 mg kg⁻¹ after the addition of cattle manure (Walker et al., 2003). Thus, the aim of this experiment is to study the effects of Residual application of three sources of organic matter: sewage sludge, municipal solid waste compost and cow manure applied to a calcareous soil on pH, electrical conductivity (EC), percentage of soil organic matter (OM%) total concentration and DTPA–extractable lead and some properties in Soil of an Industrial Zone.

Table 1. Some chemical and physical properties of soil

Texture	N (%)	AP (mg.kg ⁻¹)	AK (mg.kg ⁻¹)	OM (%)	CaCO ₃ (%)	CEC (Cmol/kg)	EC (dS/m)	pH (1 : 2)	Depth (cm)
Sandy loam	0.08	79.9	459	0.7	60	9.26	1.01	8.06	0-30

2.MATERIALS AND METHODS

This study was conducted in botanical garden of Esfahan Mobarakeh steel company in the way of Split Plot design (for soil test) at three replication. This experiment was carried out in a completely randomized block design with seven treatments including: no fertilizer as a control, sewage sludge, cow manure, municipal solid waste compost, mixture of sewage sludge and cow manure, mixture of sewage sludge and municipal solid waste compost and mixture of cow manure and municipal solid waste compost in calcareous sandy loam soil. Starting in January 2009, several rates (0, 2.5 and 5 kg/shrub) for each treatment of biosolids were applied in state of localized fertilization in distance of 50 cm from each shrub to plots of 24 ×38 m size and then done in ten irrigation periods.chemical parameters of soil such as: pH (Klute,1986) ,EC(page and miller,1982), organic matter(Rhoades,1982), total concentration (Pydt,1999;Soon and Abbond,1993) and DTPA – extractable of Pb(Lindsay and Norvell 1978) were determined.

Table 2. Some chemical properties of organic Fertilizers

Property	Unit	Sewage sludge	Municipal solid waste compost	Cow manure
pH	-	7.0	8.1	7.9
EC	ds/m	6.0	10.2	12.3
CEC	Cmol/kg	40.2	44.3	21.5
OM	%	48.7	42.5	38.5
Pb	mg/kg	100	110	55

3.RESULT AND DISCUSSION

3.1 Effect of Fertilizers on some chemical soil properties

Application of the Residual Fertilizers decreased the EC of soil significantly compared to control soil (Figure 1). Among treatments only CM had not significant effects on soil pH (Figure 2). Maximum OM% of soil was attributed to CM treatment (Figure 3).

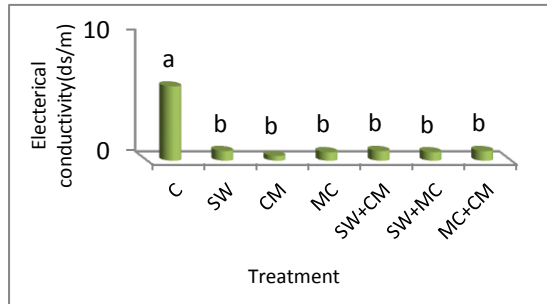


Figure 1. Effect of Residual Fertilizers application on soil electrical conductivity

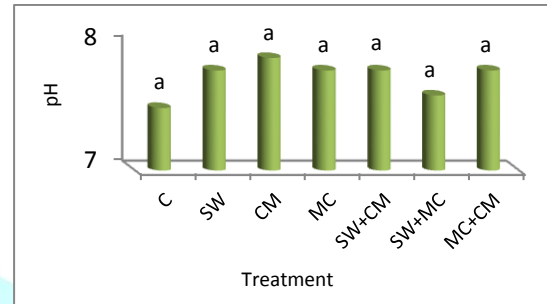


Figure 2. Effect of Residual Fertilizers application on soil pH

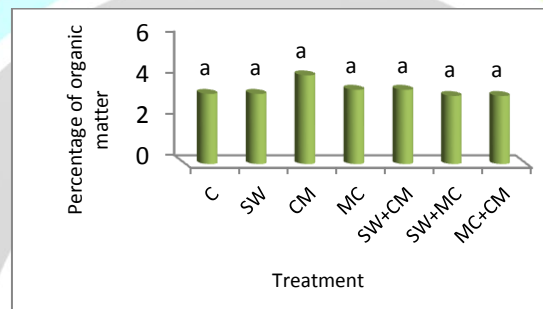


Figure 3. Effect of Residual Fertilizers application on Percentage of organic matter.

3.2 Effect of Residual Fertilizers on lead concentrations in soil total concentration

Residual Fertilizers application significantly increased the total concentrations of metals in cow manure (Figure 4).

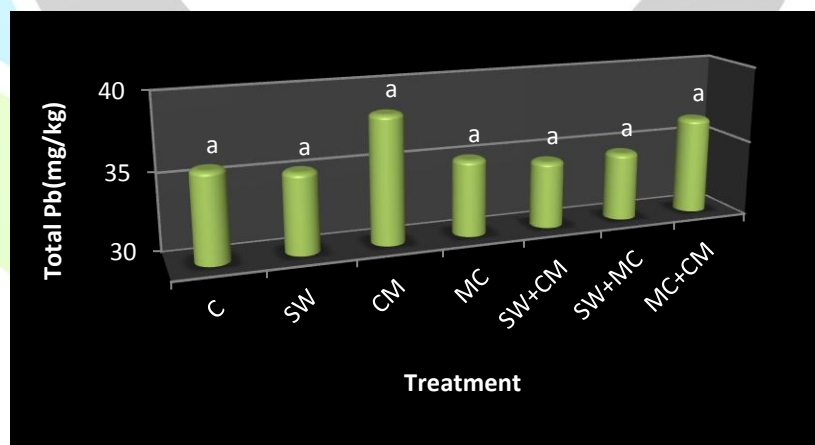


Figure 4. Total Pb concentrations in soil

3.2.1 DTPA-extractable concentrations

Residual Fertilizers application not significantly increased the DTPA extractable soil Pb and maximum rates of them showed in cow manure treatment, respectively (Figure 5).

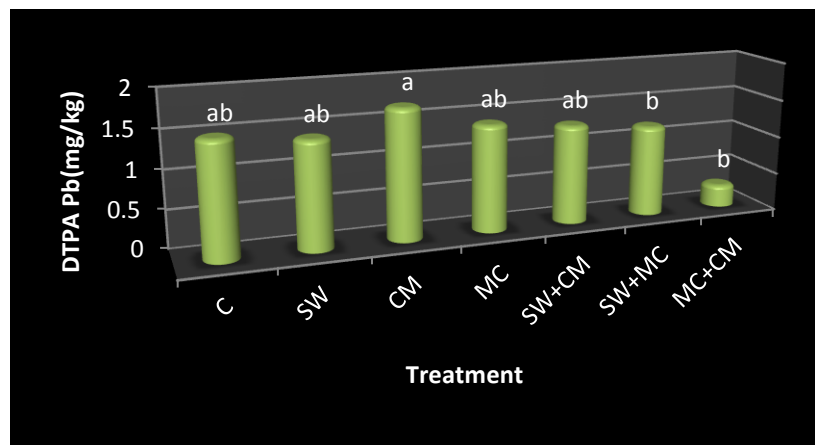


Figure 5. DTPA- extractable Pb concentrations in soil

Cow manure application increased soil pH. This mainly was because of the high buffering capacity of this calcareous soil. The result was inconsistent with results of previous studies (Karami et al., 2009; Harding et al., 1984). Increased soil pH is regarded as a major advantage when MSW compost is used Mkhabela and Warman (2005). For example, increases in soil pH from 5.8 to 6.7 and 6.1 to 6.5 (Zhang et al., 2006). The increase in the pH of soil may be due to the mineralization of carbon (Mkhabela and Warman, 2005). The EC of the soil increased significantly with Residual Fertilizers application and maximum value of EC was attributed to control treatment because remarkable salts and frequent application in agriculture soil causes the accumulation of salt in soil (Eghbal et al., 2004). The increase in OM after Residual Fertilizers application could be explained by the large amount of organic matter Pais and Benton Jones (1997). organic amendments application not significantly increased the total concentrations of metals in soil (Figure 4), the total Pb concentrations were below the respective limits of maximum acceptable concentrations (CM) in agricultural soils for these metals in countries such as Germany, Canada and Holland Pais and Benton Jones (1997). However, the concentrations of total Pb exceeded the CM for Pb in England (50 mg/kg) in cow manure treatment. The addition of Residual Fertilizers not significantly increased the DTPA extractable soil Pb compared to control due to higher metal contents (Figure 5). Some authors also reported similar findings (Jordao et al., 2003; Karami et al., 2009; and McGrath et al., 2000). One aspect which should be taken into account is that the addition of manure not only results in an increase in the total concentrations of metals, but also in the quantity of organic matter, which may have a direct effect on their solubility and bioavailability (McBride et al., 1997).

4. CONCLUSIONS

Application of sewage sludge, cow manure and municipal waste solid compost can immobilize heavy metals of soil. In this study results show that among all treatment, cow manure had most effect on concentration of total and DTPA-extractable lead, also cow manure can increase pH and organic matter of soil. EC in cow manure treatment showed minimum value.

References



- Albiach, R., Canet, R., Pomares, F., Ingelmo, F., (2000). Microbial biomass content and enzymatic activities after the application of organic amendments to a horticultural soil. *J. Bioresour. Technol.* 75, 43-48.
- Bernal, MP., Clemente, R., Walker, DJ., (2007) The role of organic amendments in the bioremediation of heavy metal-polluted soils. In: Gore RW (ed) *Environmental research at the leading edge*. Nova Science Publishers Inc., New York, (pp .1–57).
- Eghbal, B., Giinting, D., Gilley, J., (2004). Residual effect of manure and compost application on corn production and soil properties. *J. Agron.* 96, 442- 447.
- Harding, SA., Clapp, CE., Larson, WE., (1984). Nitrogen availability and uptake from field soil five years after incorporation of sewage sludge. *J. Environ. Q.* 14, 95-100.
- Jordao, CP., Cecon, PR., Pereira, JL., (2003). Evaluation of metal concentrations in edible vegetables grown in compost amended soil. *J. Int. Environ. Studies*, 60,547-562.
- Karaca, A., (2004) Effect of organic wastes on the extractability of cadmium, copper, nickel, and zinc in soil. *Geoderma* 122,297–303.
- Karami, M., Afyuni, M., Rezainejad, Y., Schulin, R., (2009). Heavy metal uptake by wheat from a sewage sludge amended calcareous soil. *J. Nutr. Cycl. Agro.* 83, 51-61.
- Karami, M., Afyuni, M., Rezainejad, Y., Schulin, R., (2009). Heavy metal uptake by wheat from a sewage sludge amended calcareous soil. *J. Nutr. Cycl. Agro.* 83,51-61.
- Li, P., Wang, X., Zhang, T., Zhou, D., HE, Y., (2008) Effects of several amendments on rice growth and uptake of copper and cadmium from a contaminated soil. *J Environ Sci* 20,449–455.
- McBride, MB., 1997. Toxic metal accumulation from agriculture use of sludge are USEPA regulatuiuns protective. *J. Environ. Qual.* 24,5 -18.
- McGrath, SP., Zhao, FJ., Dunhum, SJ., Crosland, AR., Coleman, K., (2000). Long-term changes in the extract- ability and bioa- vailability of zinc and cadmium after sludge application. *J. Environ. Q.* 29,875-883.
- Mkhabela, M. and Warman, PR., (2005). The influence of muni- cipal solid waste compost on yield, soil phosphorus avai- lability and uptake by two vegetable crops, grown in a P- awash sandy loam soil in Nova Scotia. *J. Agric. Ecosyst. Environ.* 106,57-67.
- Pais, IJ. and Benton Jones, Jr., (1997). *The hand book of trace elements*. Publishing by: St. Lucie press Boca Raton Florida.
- Sastre, I., Vicente, MA., Lobo, MC., (1996). Influence of the application of sewage sludges on soil microbial activity. *J. Bioresour. Technol.* 57,19-23.
- Vasseur, L., Cloutier, C., Anseau, C., (2000). Effects of repeated sewage sludge application on plant community diversity and structure under agricultural field conditions on Podzolic soils in eastern Quebec. *J., Agric. Ecosyst. Environ.* 81,209-216.
- Walker, DJ., Clemente, R., Bernal, P., (2004) Contrasting effects of manure and compost on soil pH, heavy metals availability and growth of *chemopodium album* in a soil.
- Walker, DJ., Clemente, R., Roig, A., Bernal, MP., (2003) The effects of soil amendments on heavy metal bioavailability in two contaminated Mediterranean soils. *Environ Pollut* 122,303–312.
- Zhang M, Heaney D, Henriquez B, Solberg E, Bittner E (2006). A fouryear study on influence of biosolids/MSW compost application in less productive soils in Alberta: nutrient dynamics. *J. Comp. Sci. Util.* 14: 68-80.